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PLANETARY TRANSMISSION

The invention concerns a planetary transmission according to the generic portion of patent claim 1.

A similar transmission with a two-stage design is known from EP 0 824 640 B1.

The invention concerns itself with the problem of being able to achieve a significantly greater transmission ratio and torque transfer in this type of transmission without significantly enlarging the overall volume. In addition, the stiffness of the transmission is to be elevated significantly. Furthermore, the transmission is to be economically producible with simple means and is to ensure low-wear operation and transmission with little play.

This problem is solved through the embodiment of a transmission of this type according to the characterizing features of patent claim 1.

Advisable embodiments are the object of the sub-claims.

By using four planet wheels across the width in individual transmission stages, on one hand, high torques can be transmitted in these transmission stages, and, on the other hand, the stiffness of the transmission is significantly elevated.

Unexpectedly favorable transmission ratios resulted when the transmission stages were each designed with four planet wheels in a planet carrier having a transmission ratio of i = 5.5, particularly when the internal gear had 108 teeth. Total transmission ratios which were even could be achieved, particularly if an odd transmission ratio i = 5.5 was used.

In a planetary transmission implemented in three stages according to the invention, the overall transmission ratio can be calculated according to the formula

$$i_{ov} = i_1 \times i_2 \times i_3 - (i_1 \times i_2 - 1)$$

According to this, a maximum practically achievable transmission ratio is i = 901.

An exemplary embodiment subsequently described in more detail is shown in the drawing.

Fig. 1 shows a schematic view of a three-stage planetary transmission,

Fig. 2 shows a planetary transmission implemented in an alternative way to the implementation shown in Fig. 1.

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DESCRIPTION OF THE EMBODIMENT SHOWN IN FIG. 1

The rotatable parts of a three-stage planetary transmission are mounted inside a transmission housing 1. In the exemplary embodiment shown, the transmission gears down from left to right.

The three transmission stages are labeled with I, II, and III.

Sub C37

In the first transmission stage I, a first sun wheel 2, which can be driven from outside, engages in first planet wheels 3, which are mounted in a first planet carrier 4. Three first planet wheels 3 are mounted in the first planet carrier 4, distributed across its width.

Sub B37

The first planet wheels 3 mesh in an internal gear 6, which is rigidly connected with the planet carrier of the third

stage III, defined here as the last planet carrier 5. The internal gear 6 and the last planet carrier 5 rotate at the same speed due to their rigid connection with one another. Second planet wheels 7, four of which are mounted across the width of an associated planet carrier 8 in the second transmission stage II, mesh in a second internal gear 13, which is rigidly connected in the same way as the first internal gear 6 with the last planet carrier 5, from the second transmission stage II. In the transmission axis, a second sun wheel 9, rigidly connected with the first planet carrier 3, engages in the second planet wheels 8 of the second transmission stage II.

B3

Sub B4

A last sun wheel 10, connected rigidly with the second planet carrier 8, engages, from this carrier outward, in last planet wheels 11 of the last planet carrier 5 of the third transmission stage III. Four last planet wheels 11 are distributed over the width of this last planet carrier 5.

The last planet carrier 5 forms the driven shaft in a speed-reducing transmission.

The two first transmission stages I, II act functionally as if they are connected in series.

Sub C5

With the transmission described, a transmission ratio of $i = 181$, for example, can be achieved if the internal gears in which the planet wheels engage each have 108 teeth, the transmission ratios in the individual stages are $i_1 = 10$, $i_2 = 4$, and $i_3 = 5.5$, and in the last transmission stage, i.e. the third in this case (III), there are four planet wheels installed across its width, with only three planet wheels in each of the first two transmission stages.

In a transmission according to the invention which has the approximately the same volume as that known from EP 0 824

640 B1, but is slightly larger, an increase of more than 50 % in the torque to be transmitted can be achieved. In the same way, an increase of approximately 50 % in stiffness is also possible. These increases result, besides from the additional transmission stage, particularly from a use of four planet wheels in each of the two driven stages II, III, and from the selection of a transmission ratio of i = 5.5 in the transmission stages II, III, each of which are equipped with four planet wheels.

Sub C6

Naturally, the first transmission stage I can also be implemented with four planet wheels distributed across its width.

As in the known transmission according to EP 0 824 640 B1, the driven planet carrier is also in this case to be mounted on roller bearings inside the transmission housing 1 on both sides of the planet wheels it carries, and is to be axially fixed.

The individual planet wheels are mounted in the planet carriers with as little friction as possible in a way typical per se.

For transmission of higher moments, a three-stage transmission according to the invention can be advantageously designed as follows.

- All internal gears have a number of teeth z = 108.

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- In the third transmission stage, four planet wheels are provided in the planet carrier distributed across its width and i_3 = 5.5 is set as the transmission ratio.

Sub C8

- In the second transmission stage, either four or three planet wheels are provided in the planet carrier

C8

distributed over its width and $i_2 = 4$ or $i_2 = 5.5$ is set as the transmission ratio for this stage.

Sub C9

In the first transmission stage, three planet wheels are provided in the planet carrier distributed over its width and $i_1 = 3, 4, 5, 7, 10$ can be set as the transmission ratio for this stage.

Sub C10

For an internal gear with z = 108 teeth, surprisingly, with a predetermined transmission ratio of i = 5.5, four planet wheels can be used in an associated planet carrier, distributed across its width. In spite of this odd single stage transmission ratio, an even overall transmission can be achieved through kinematics according to the invention.

A particular advantage is that, through the transmission kinematics according to the invention and possible individual or overall transmission ratios, in a three-stage transmission, for example, uniform reliability of the gearings can be achieved, which allows, in turn, high transmittable moments with, at the same time, low wear.

Only a slight, extremely damped noise emission issues outside the transmission housing from the rapidly running and therefore noise-intensive first two transmission stages. This is because the rotating parts of the first two transmission stages are not connected directly with the fixed transmission, and therefore, structure-borne noise issuing from them is only relayed over long paths with parting lines, which practically corresponds to a noise enclosure.

With a number of teeth z = 108 for the internal gears and transmission ratios of a maximum of i = 10 each in all three transmission stages, as well as three planet wheels distributed across the width in each transmission stage, a

maximum transmission ratio of i = 901 can be achieved according to the formula indicated above.

DESCRIPTION OF THE EMBODIMENT SHOWN IN FIG. 2

The difference in the embodiment shown in Fig. 2 relative to that shown in Fig. 1 is that the first and second internal gears 6, 13 are not rigidly connected with the last planet carrier 5, but with the transmission housing 1.

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